Space Weather Technical Forecast

Issued on Monday, 26 September 2022 at 13:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of R1 Minor Radio Blackouts throughout. Chance of CME arrival day 1 or early day 2, with slight chance G1 Minor geomagnetic storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES-16 and 17 satellites, has been Low with C-class flares observed. Peak flare was a C4.7 at 26/0911 UTC from AR3107 Fai/Beta-Gamma. This is one of five numbered active regions on the disc, and a part of a complex of sunspots that includes AR3105 Dai/Beta-Gamma in the southern central disc. Very little growth has occurred in either region. The largest region, in terms of area, is currently AR3110 Eso/Beta in the northeast quadrant has persisted as a simple bipolar configuration, with some further decay of any intermediate spots. AR3108 Cso/Beta and AR3109 Axx/Alpha are smaller and simpler regions on the western hemisphere. No Earth-directed CMEs have been observed in the last 24 hours, although a CME was observed leaving the Sun from near the southeast limb.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, has been at background speeds of around 300 km/s since 25/1415 UTC, however the density of the wind has gradually increased to be above average, peaking 14 ppcc, since the same time. There are a couple of potential causes of this, including a weak transient moving across Earth at these background speeds, perhaps associated with a CME that was anticipated to glance late on the 25th or early 26th , or potentially Earth is grazing along the periphery of CH26/-, with a subsequent enhancement possible later on day 1 (26th). The total Interplanetary magnetic field strength (IMF), Bt, was weak throughout, below 7nT, with its north-south component also weak, between -4nT and +4nT, but with a trend from mainly negative values to be more variable. The phi angle was largely in the positive (away from the Sun) direction until 26/0930 UTC, when it rotated into the negative (towards the Sun) direction. Geomagnetic activity was Quiet (Kp 0 to 2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained very close to Background levels. High energy electron flux (greater than 2 MeV) initially rose from Moderate levels to High, with a peak value of 2130 pfu at 25/1555 UTC, before declining back to Moderate levels. A similar trend is being observed on the 26th. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 26/0000UTC was 5.43e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, with a daily Chance of isolated M-class flares, primarily from AR3107, but potentially also from AR3105 and AR3110.

Solar Wind / Geomagnetic Activity: Current background winds have the potential to become slightly enhanced later day 1 (26th) or 27th) due to the glancing arrival of a weak CME (from a central disc dimming on the 22nd), or from any interaction with the fast wind of the southern coronal hole CH26/-. Both of these are low confidence. Any enhancement will then gradually ease day 3 and day 4 (28th and 29th) with solar winds returning to background. Geomagnetic conditions are likely to be Quiet at first, but increasing to Unsettled with a chance of Active intervals later day 1 or early day 2 (26th or 27th). There is the potential for Active to G1/Minor

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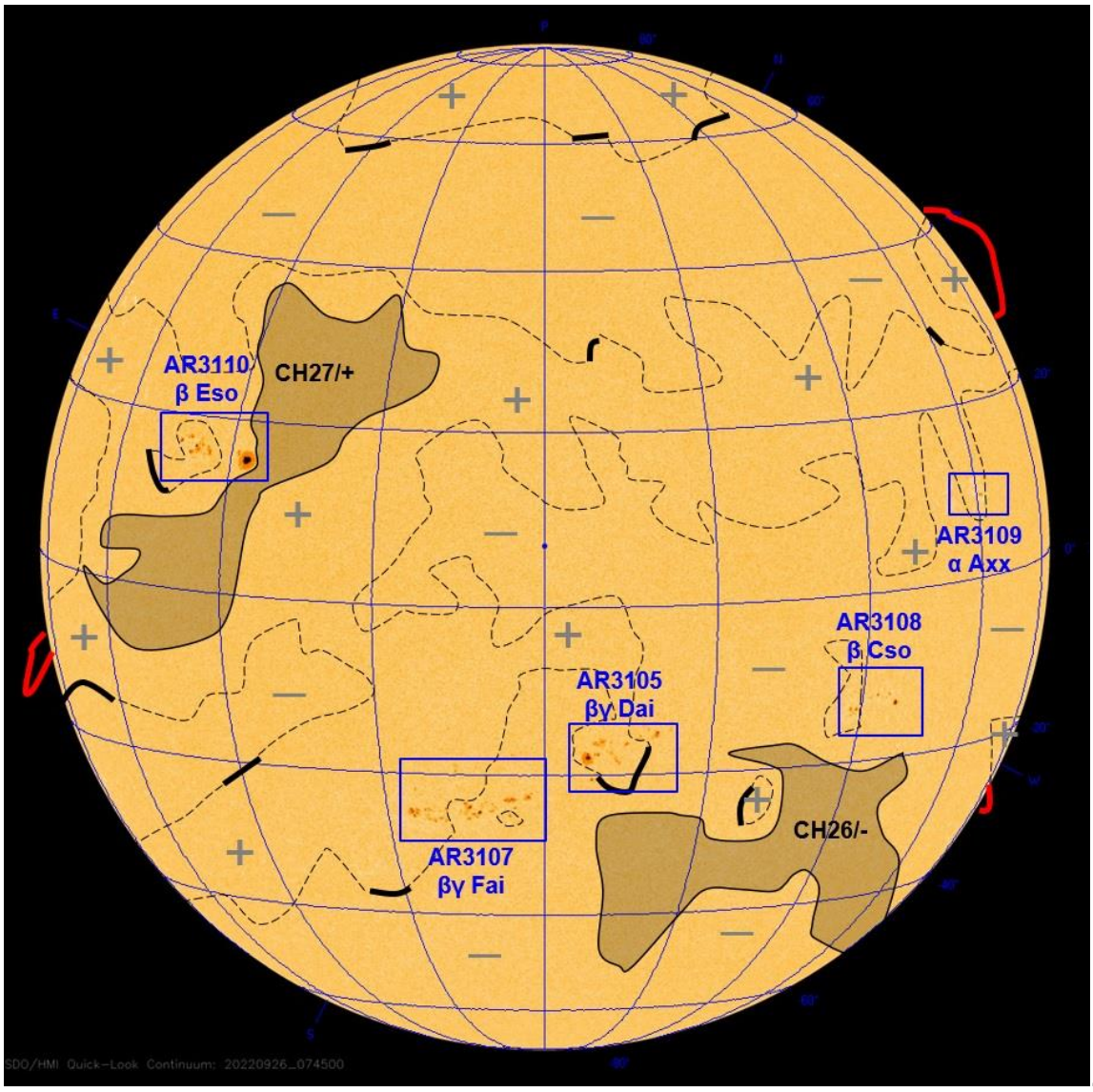
Storm if any CME arrival occurs in the same time period. Conditions easing to mainly Quiet with isolated Unsettled intervals day 3 (27th) onward.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES16, is expected to persist at Background levels. The high energy electron flux (greater than 2 MeV) is expected to be mostly at Background to Moderate levels, with a chance of reaching High levels during the diurnal peaks over the next day or two. Confidence in the forecast is lowered due to possible glancing CME influence and CH affects later day 1 and day 2 (26th-27th). The associated 24-hour fluence is expected to stay below the Active (1e8 integrated pfu) threshold through the period.

Figure 1. Solar Analysis Valid 26/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Solar winds are currently at background speeds, but with elevated density, either due to the peripheral influence of CH26/-, or perhaps due to a weak transient passing through, maybe associated with the weak CME from the 21st Sep. A further CME arrival, from a central disc dimming on the 22nd due to a magnetic reconfiguration, is possible later on day 1 (26th) into day 2 (27th). Confidence is again low, with only a glancing interaction likely.

Otherwise connection to CH26/- is possible later day 1 or 2 (26th or 27th), before easing day 3 (28th) onward. The 27 day Solar wind persistence suggests an enhancement up to 500-600 km/s at this time, however this signal was contaminated by CME arrivals on the previous rotation. Enlil connected Earth to this feature on the 25th, which was too early, but is still likely giving a good guide on potential peak winds, of around 500 km/s. Due to the negative polarity of the feature, any geomagnetic activity is expected to be limited.

Geomagnetic conditions are likely to be Quiet at first, but increasing to Unsettled with a chance of Active intervals due to the coronal hole 26 later day 1 or early day 2 (26th or 27th). There is the potential for Active to G1/Minor Storm if any CME arrival occurs in the same time period. Conditions easing to mainly Quiet with isolated Unsettled intervals day 3 (27th) onward.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
23/0659	Partial	Coronal dimming	SW	400 km/s	Late 26th or Early 27th	Low confidence. Glancing interaction only.

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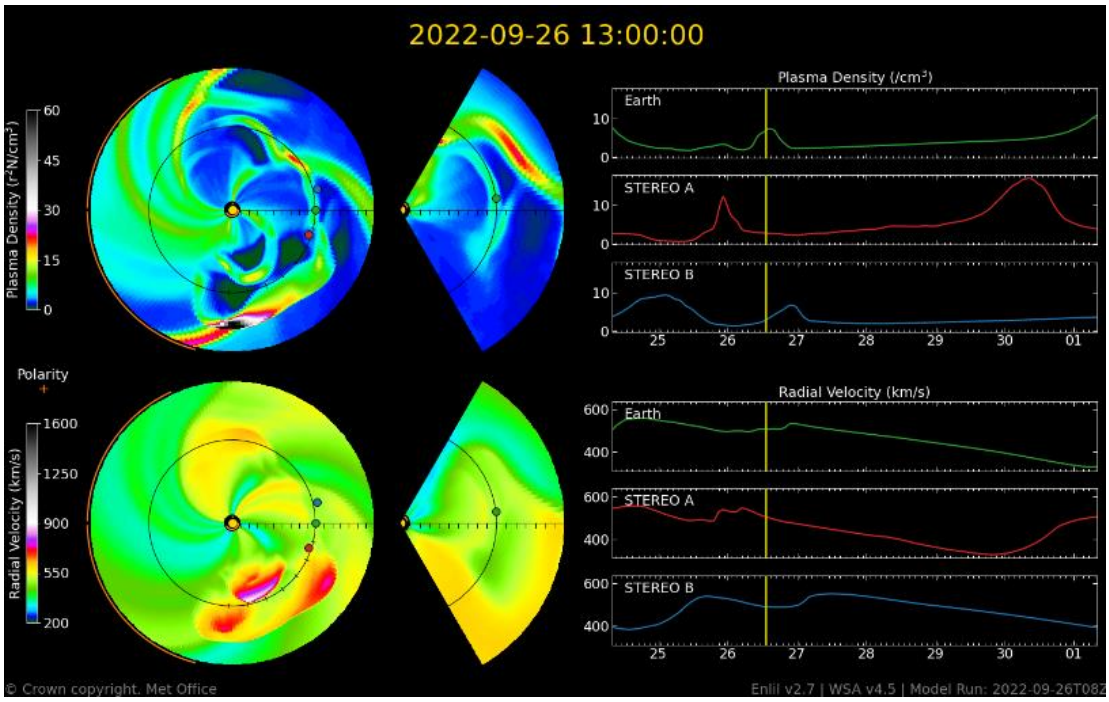
Figure 2: Enlil with ensemble



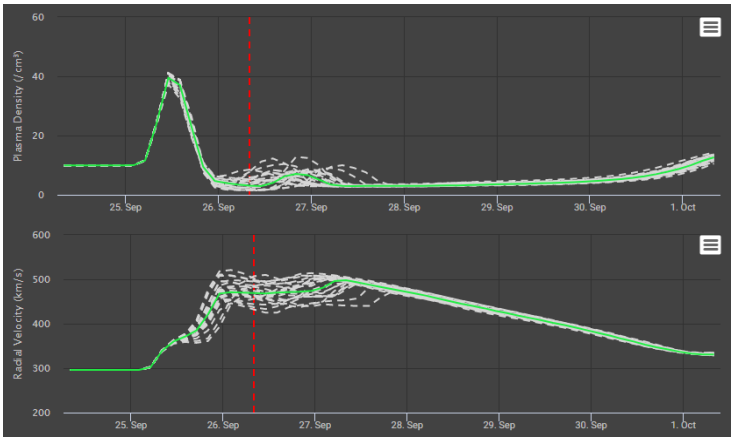
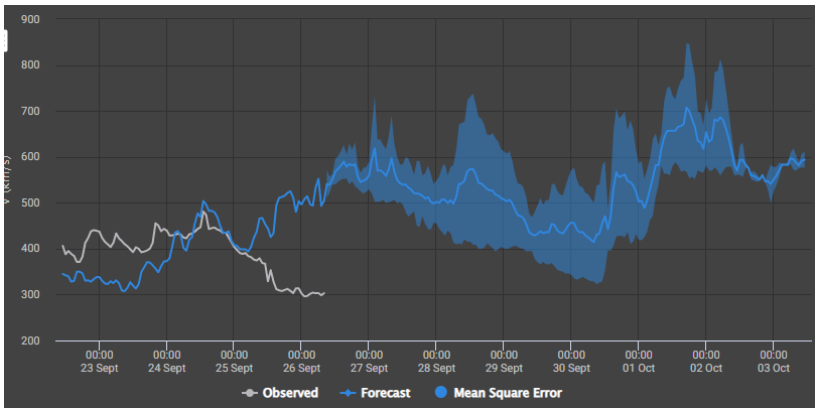


Figure 2b: MOSWOC Solar wind Persistence Model. Difference with persistence likely due to CME arrivals on previous rotation.



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Radio Blackouts - X-Ray Flares:

Solar activity has been Low with five numbered sunspot regions on the disc. Low activity is expected to continue, with a chance of isolated M-flares.

A complex of two longitudinally extensive sunspots AR3105 Dai/Beta-gamma and AR3107 Fai/Beta-gamma is currently traversing the central southern disc. The latter of these was the source of a long period C4.7 flare, which was the peak observed in the last 24 hours. The magnetic configuration of these regions remains relatively simple and stable, with only a very small and recently developed opposite polarity spot near their trailer and leader respectively, resulting in the beta-gamma classification. However, these do have the potential to produce M-flares.

The other main region of note is AR3110 Eso/Beta in the northeast. This has the largest penumbral areal size of the current spots, and also has the potential for M-flaring, but is currently a simple and stable bipolar region. The other two regions are both smaller and simple.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3a: GOES-16/17 X-ray flux

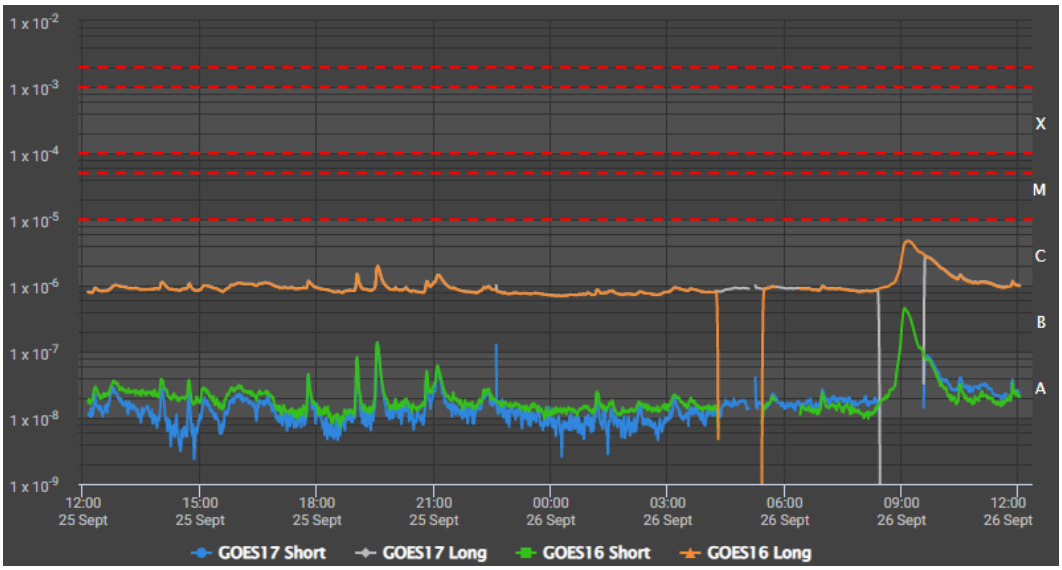

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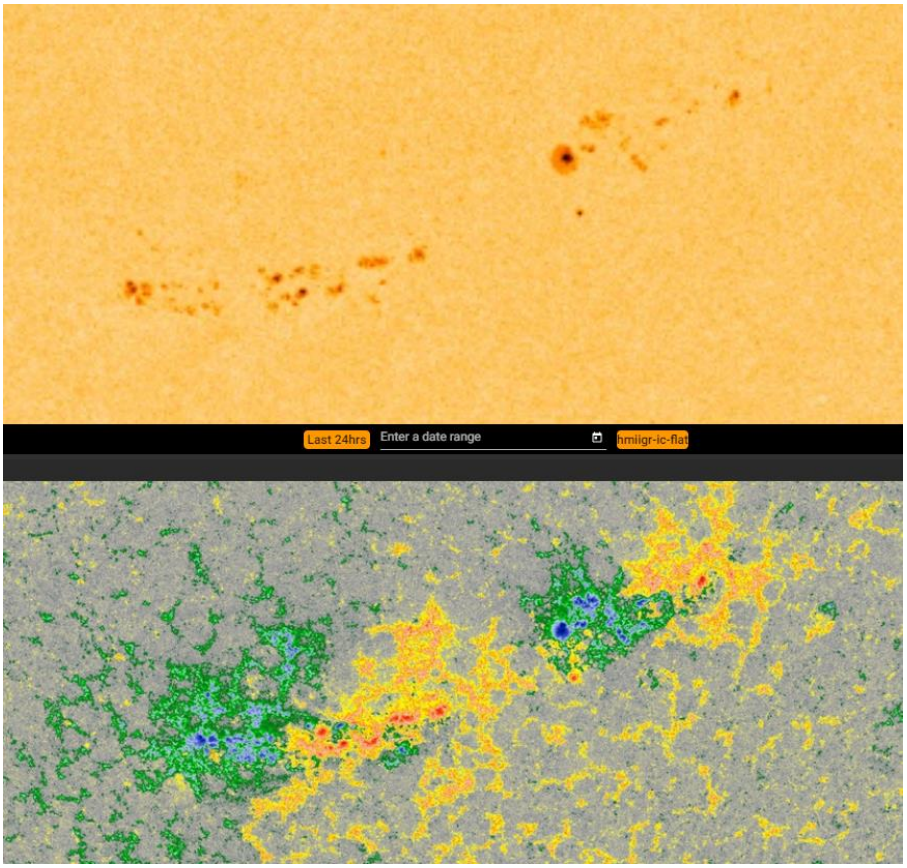
Figure 3b: SDO hmi intensitygram (top) and magnetogram (bottom) of main complex of sunspots AR3107 (left) and AR3105 (right)



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at or very close to Background levels. The main risk of any proton enhancement is from AR3105 and AR3107, as they move into the southwest disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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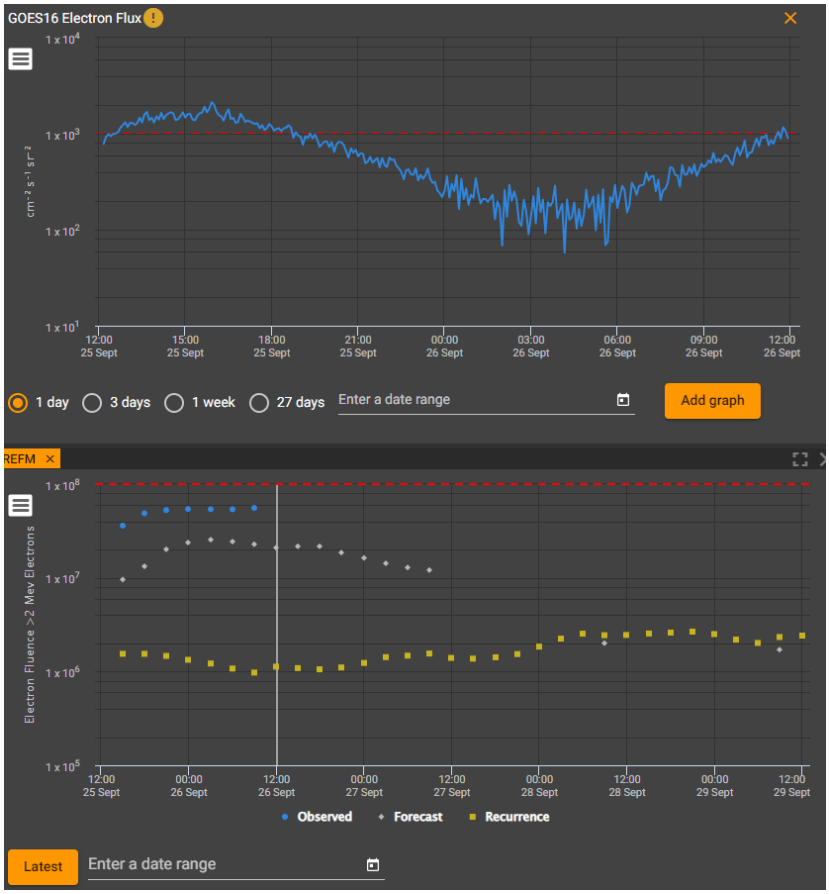
High Energy Electrons Event (≥ 2MeV):

The high energy (greater tan 2MeV) electron flux, as observed by GOES-16 has been varying between Moderate and High levels, but is likely to see peak values decline due to any CME or coronal hole fast wind arrival later on day 1 or early day 2 (26th or 27th). This is low confidence however, and should it occur, a further rise in peak flux is possible towards the end of the period, perhaps briefly peaking at high levels.

The associated electron 24 hour fluence is expected to remain below the active (1e8 integrated pfu) threshold, with REFM giving good guidance of expected fluence in the absence of any potential decrease in flux on days 1 or 2 (26th and 27th). This keeps values well below the Active threshold. Any rise by the end of the period is possible, but very low confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2 MeV Electron Flux and associated Fluence with REFM (white) and persistence (yellow).



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